Heavy-light decay constants using clover valence quarks and three flavors of dynamical improved staggered quarks

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Outline

- Background
- What's New
- Analysis and Results
- Future

Background

- Decay constants are important for CKM matrix elements
  - e.g., $\Gamma(D_s^+ \to l^+\nu_l) \propto f_{D_s}^2 |V_{cs}|^2$
- Decay constants are a good way to verify the accuracy of our techniques
- We use Clover quarks with Fermilab interpretation and Asqtad three-flavor dynamical configurations
- Calculation began in 2001 and will be superseded by new FNAL/MILC calculation with Clover heavy quarks and Asqtad light quarks (Simone talk)

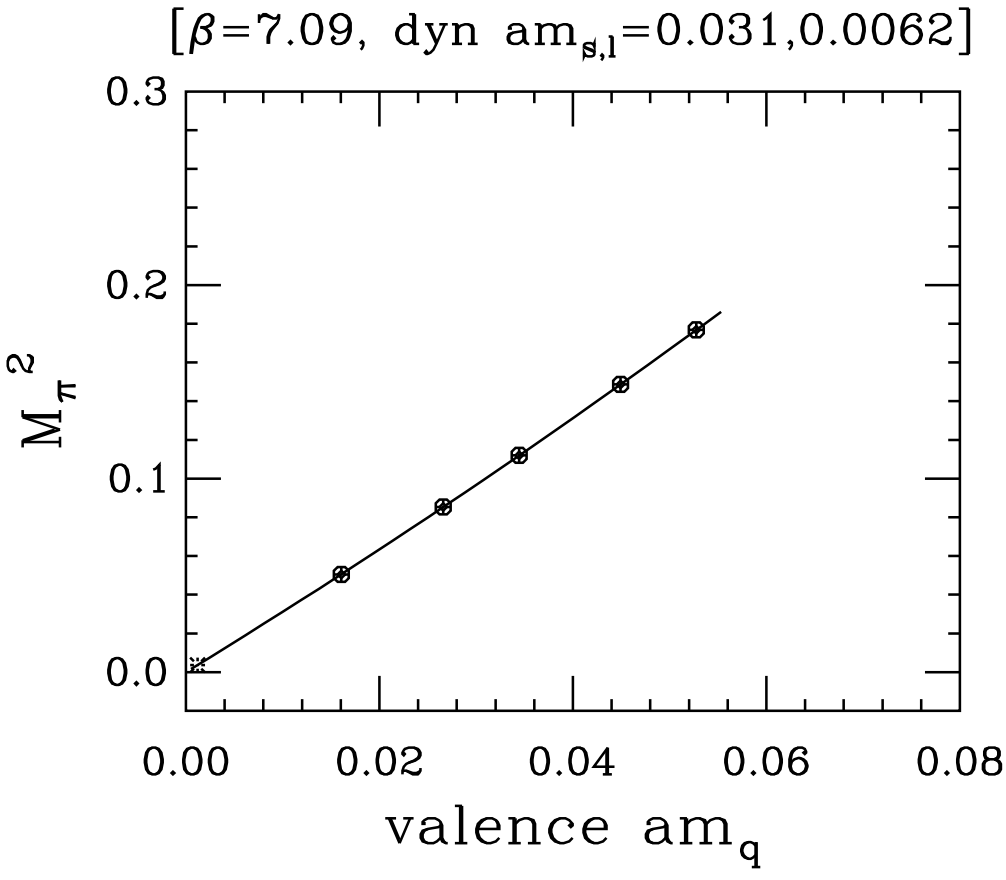
What's New

- One-loop perturbative normalization Z_A has just become available (El-Khadra, Nobes, Trottier)
- Two ensembles of $a = 0.09$ fm configurations now have greatly increased statistics.

dynamical $am_{u,d}/am_s$	β	configs. generated	configs. analyzed
$a = 0.09$ fm; $28^3 \times 96$			
0.031/0.031	7.18	496	163
0.0124/0.031	7.11	527	242 (120)
0.0062/0.031	7.09	592	293 (48)

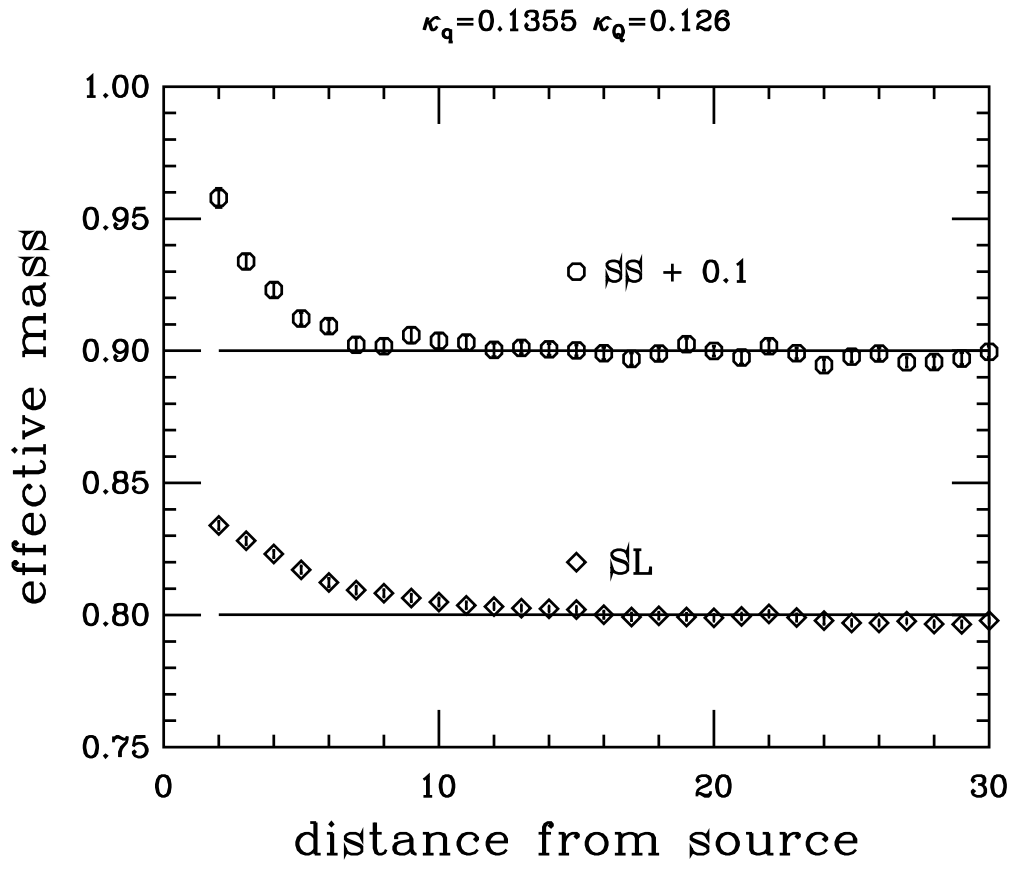
Analysis and Results

1. fit light pseudoscalar masses
2. chiral fit of pseudoscalar masses determines κ_c

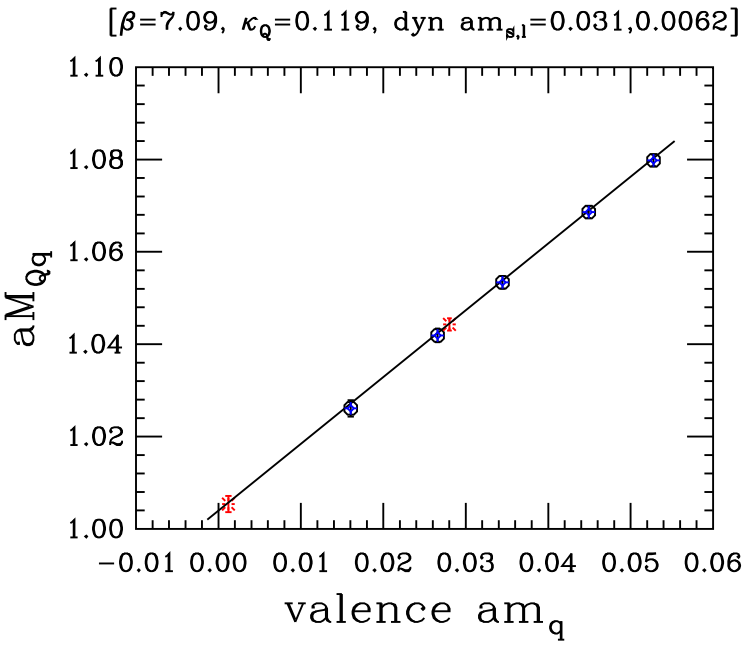


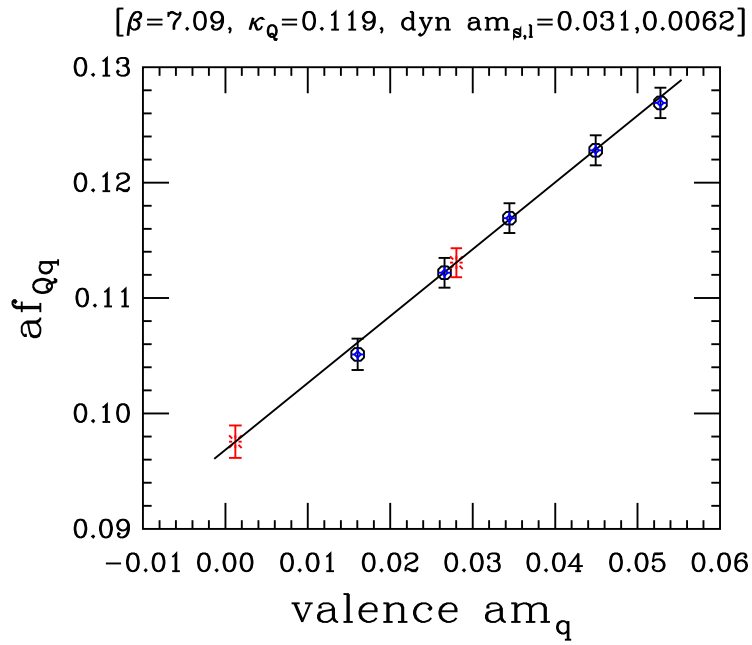
3. fit light vector meson masses
4. chiral fit of vector meson masses just for reference (We now get a from heavy quark potential.)
5. determine m_s from mass of $\bar{s}s$ pseudoscalar state assuming linear chiral mass relation

6. fit heavy-light channels to determine masses and decay amplitudes

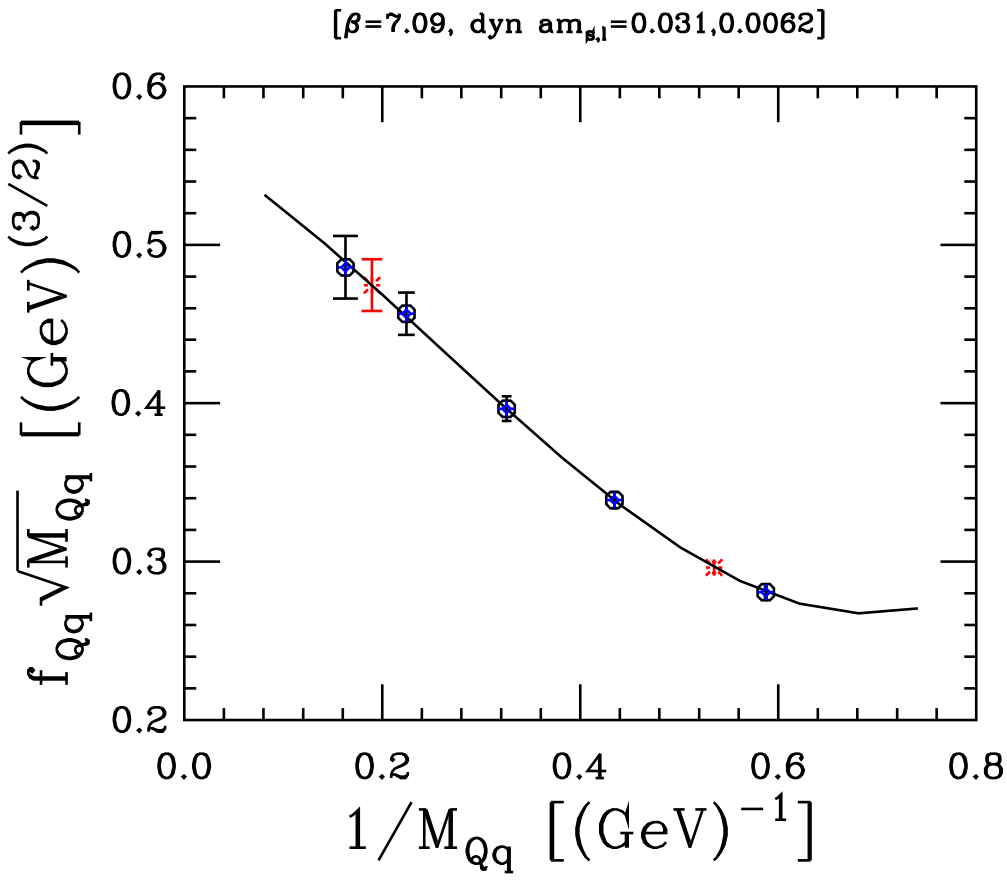


7. extrapolate or interpolate results in light quark mass to $m_{u,d}$ or m_s





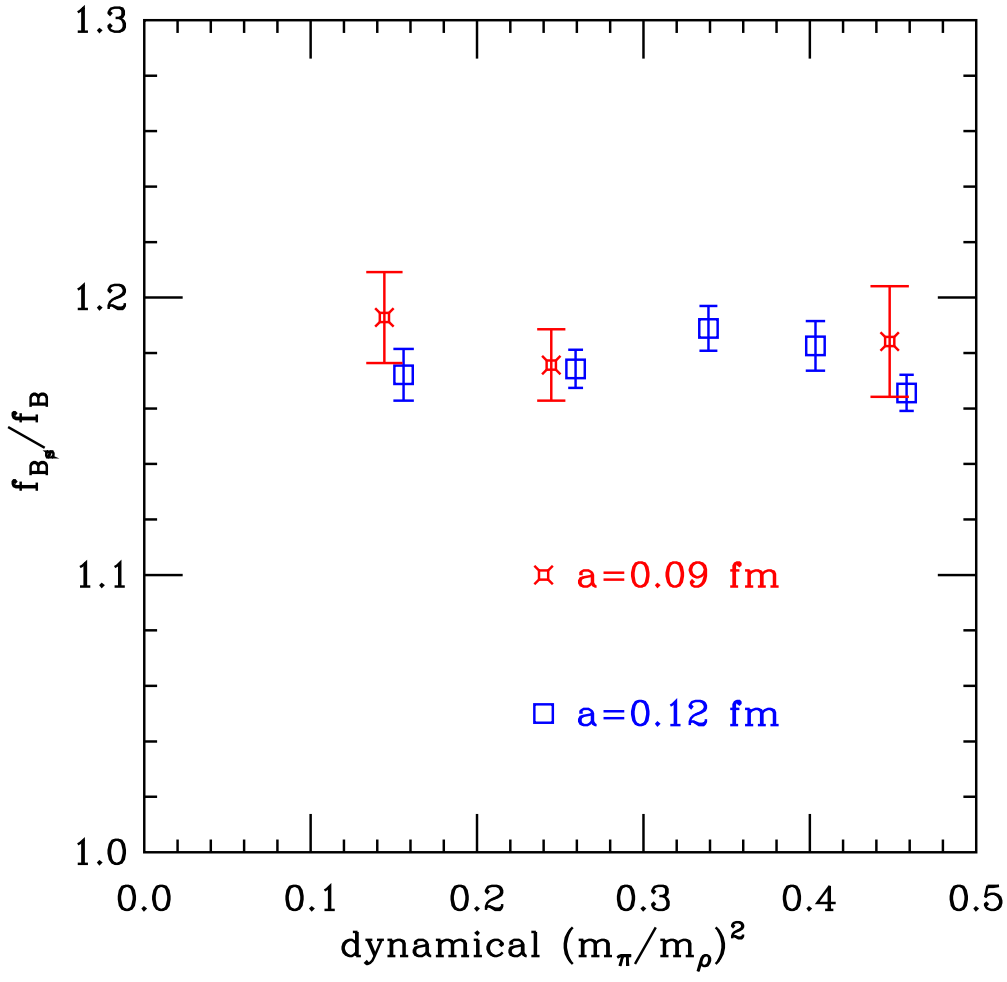
8. after removal of perturbative logarithms, fit $f_{Qq}\sqrt{M_{Qq}}$ to a power series in $1/M_{Qq}$ and interpolate to B, B_s, D and D_s meson masses



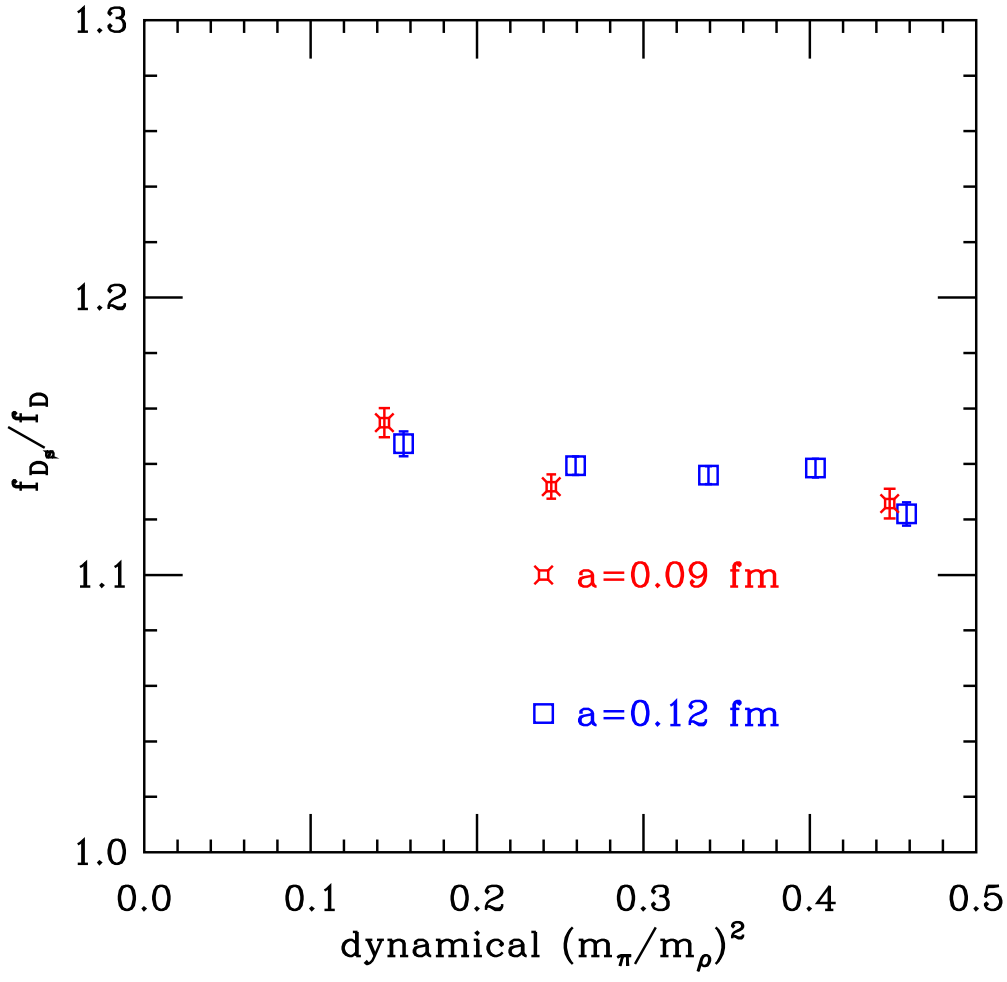
9. put the logarithm back and use the heavy-light axial-vector current renormalization constant to get the renormalized decay-constant

After the above procedure is done on each ensemble, we have a partially quenched result at a particular value of dynamical M_π/M_ρ. We then plot these results as a function of $(M_\pi/M_\rho)^2$ to perform a chiral extrapolation. This is demonstrated for f_{B_s}/f_B and f_{D_s}/f_D:

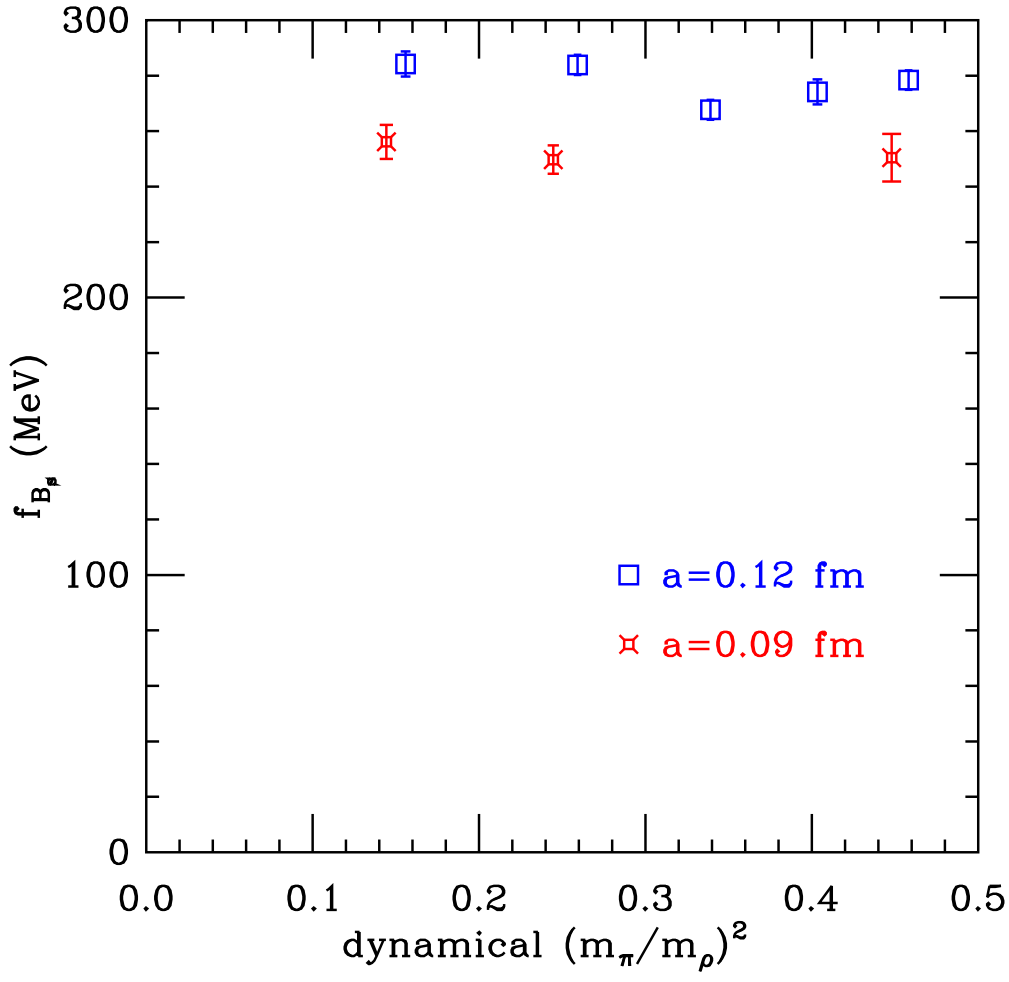
f_{B_S}/f_B


1.3
1.2
1.1
1.0
0.0
0.1
0.2
0.3
0.4
0.5
f_{B_s}/f_B
dynamical $(m_\pi/m_\rho)^2$
a=0.09 fm
a=0.12 fm

f_{D_S}/f_D


1.3
1.2
1.1
1.0
0.0
0.1
0.2
0.3
0.4
0.5
f_{D_s}/f_D
dynamical $(m_\pi/m_\rho)^2$
a=0.09 fm
a=0.12 fm

f_{B_S}


300
200
100
0
f_{B_s} (MeV)
0.0
0.1
0.2
0.3
0.4
0.5
dynamical $(m_\pi/m_\rho)^2$
a=0.12 fm
a=0.09 fm

Future

- Complete the analysis including alternative cuts on fits, chiral extrapolations, etc.
- Check renormalization of axial vector current: compare with tadpole improvement and $Z_A^{hl} = \rho_A^{hl}\sqrt{Z_V^{hh} Z_V^{ll}}$ where ρ_A^{hl} is computed perturbatively and Z_Vs nonperturbatively.
- Probably will not increase statistics, or run additional ensembles. (There are additional $N_f = 3$ $m_s = m_l$ and quenched results not shown here.)
- In collaboration with FNAL, extending calculation using improved staggered quarks for the light quarks that allows much closer approach to chiral limit (see Wingate *et al*. PRD **67**, 054505 (2003).)